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AEROATOMIC WEAPON DATA
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HISTORY OF THE MK 53 WEAPON (U)

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Weapon Systems

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Information Research Division, 3434

Redacted Version

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Timetable of Mk 53 Events

(b)(1), (b)(3)

9/2/58	Division of Military Application requests estimate of operational availability date.
10/15/58	Los Alamos and Sandia submit tentative development schedule.

(b)(3)

6/17/59	Sandia forwards development program definition of TX-53 to the Albuquerque Operations Office.

(b)(3)

10/21/59	Proposed ordnance characteristics of TX-53 accepted by the Special Weapons Development Board.
3/13/60	Study of an XW-53/TITAN Warhead published.
5/17/60	Director of Defense Research and Engineering requests Atomic Energy Commission to participate in feasibility study of warheads for TITAN II missile.
7/12/60	Warhead feasibility study recommends development of an XW-53 Warhead for TITAN.
9/1/60	Director of Defense Research and Engineering requests Atomic Energy Commission to develop XW-53 Warhead.

(b)(1), (b)(3)

History of the Mk 53 Weapon

(b)(1), (b)(3)

This device pointed the way to development of the Mk 53.

(b)(3)

Subsequently, the Division of Military Application wrote to Albuquerque Operations Office, September 2, 1958, requesting that preliminary arrangements be made, but stating that full authorization would not be released until the military characteristics had been issued by the Department of Defense.[4] An estimated operational availability date was requested.[5]

The Los Alamos Scientific Laboratory and Sandia submitted a tentative development schedule October 15, 1958.

(b)(1), (b)(3)

Los Alamos and Sandia held a joint meeting November 13, 1958. The bomb would be carried in B-47 and B-52 aircraft, with possible application to the B-58 Pod and perhaps even to the B-70. However, the high speed of the B-70 would create high bomb-bay temperatures, and it was felt that this might seriously affect such items as the parachute and the high explosive used in the design.[7] Various cooling methods were considered, including insulation of bomb-bay walls, use of a jettisonable water jacket, or filling the bomb bay with a low-density material blown in after the weapon had been loaded in the strike aircraft. It was noted that the bomb dimensions were limited by the size of the B-47 bomb bay and that redesign or repackaging of some weapon components might be necessary.[8]

(b)(3)

Sandia studied several possible ways of stabilizing the bomb in flight. Fin deployment appeared necessary for a number of reasons. There was an adverse center-of-gravity location, and the aircraft bomb bay limited the fin height. Aerodynamic requirements required stabilization of the bomb shortly after release, and it was felt that a large fin area would be needed. It would be necessary to provide mechanical devices between the fins to make sure that all four fins deployed simultaneously.[10]

(b)(1), (b)(3)

Sandia forwarded the TX-53 development program definition to Albuquerque Operations Office June 17, 1959.

(b)(1), (b)(3)

Delivery methods for the B-58 Two-Component Pod, recently redesignated the BLU-2/B Pod, would include high-altitude free fall and possibly low-level pop-up. Use of the bomb less parachute container and fins as a laydown device in an MB-1-type Pod would also be considered.

The Department of Defense would provide a parachute, and the Atomic Energy Commission would be responsible for nuclear design and the rest of the bomb. Units furnished for the B-58 Pod application would contain complete fuzing and firing systems, with the exception of pressure-sensing and contact-fuzing devices supplied by the Air Force. Sandia would provide the engineering and production specifications for all other fuzing components and materials.

The program schedule would depend on successful development of materials for mitigating high shock, high-strength light materials for secondary nuclear component support, and high-strength aluminum for the weapon case. The aerodynamic shape would have extendible fins to provide proper stability of free-fall bombs released at high altitudes.

The B-70 bomb application would be sufficiently unique to require a field modification kit to provide the required aerodynamic and heat-resistant qualities. This kit would be design released after compatibility had been proven in flights and drops from B-70 aircraft, but it was predicted that such aircraft would not be available until about mid-1962.

(b)(1), (b)(3)

(b)(1), (b)(3)

Since the deformation switch used to produce contact firing signals in the complete bomb was different than the corresponding components in the Pod application, a connector was provided on the weapon skin to allow either type of deformation switch to be used.

(b)(1), (b)(3)

On July 15, 1959, the Air Force proposed that Sandia be responsible for providing pressure-sensing and contact-fuzing devices, rather than the Military, and this proposal was subsequently accepted by the Military Liaison Committee.[19]

An amendment to the military characteristics was issued August 4, 1959.

(b)(1), (b)(3)

A ballistic drop test was held September 12, 1959, and indicated need for modification of the low-level deployment sequence.

(b)(1), (b)(3)

The Air Force Special Weapons Center had requested a list of changes that would have to be made to provide a fuzing and firing system compatible with the low-level Special Weapons Emergency Separation System.

(b)(1), (b)(3)

Field Command wrote to the Air Force Special Weapons Center October 5, 1959, proposing that the variable timer for the laydown option be replaced with a single fixed time delay. This change would provide increased reliabiltiy and safety by eliminating the setting mechanism and the human effort involved in making the setting, and environmental protection would be increased, since the case would not have to provide a seal around the rotary shaft of the variable timer.[23] The Center replied October 16, 1959, noting that the Strategic Air Command had been queried, and a preference stated for the variable timer.[20]

Report SC4267(TR), Proposed Ordnance Characteristics of the Basic TX-53 and the TX-53 Bomb, was presented by Sandia to the October 21, 1959 meeting of the Special Weapons Development Board.[24] This noted that the Basic TX-53 would contain a high-explosive implosion system, nuclear pit, gas-boosting system, secondary, electrical fuzing and firing system, primary case and Basic TX-53 case. The TX-53 Bomb would consist of the Basic TX-53, aft assembly with retardation parachute, extendible fins, shock-mitigating material, and nose assembly with impact switch.[3] The report was accepted and forwarded to the Division of Military Application December 4, 1959.[25]

Sandia had informed the Division of Military Application that the bomb would have to be thermally protected when carried in the B-70 aircraft, to maintain the bomb temperature below 165°F. This protection could be provided by bomb-bay cooling or insulation. Any modification to the bomb to provide the shock-mitigation system, afterbody or parachute with materials which could resist high temperatures would require at least 15 months of effort and would increase the weapon diameter to 52 inches, the length to 164 inches, and the weight to 9300 pounds.[26] Subsequently, December 10, 1959, the Air Force requested that any work toward establishing compatibility of the TX-53 Bomb with B-70 aircraft be halted, due to delays in the latter program.[19]

(b)(1), (b)(3)

Sandia informed the Air Force Special Weapons Center that the TX-53 Bomb experienced severe pitchdown in drop tests made from B-47 aircraft. This caused parachute deployment problems, imposed high aerodynamic loads on the bomb, and increased the possibility of contact between bomb and aircraft during weapon releases. Separation from B-52 aircraft appeared satisfactory.[30]

The Center replied February 8, 1960, noting that the B-47 bomb bay had caused problems in the past, but that this had not prevented designers from achieving weapon compatibility without modifying the bomb bay. This latter work would require extensive aircraft modification and probably result in performance degradation. It was noted that there appeared to be close correlation between delivery speeds and weapon release characteristics. Since the B-52 was being modified to permit low-level flight at 400 knots, it was requested that separation tests of bomb from B-47 at this speed be conducted.[31]

Sandia notified Field Command February 16, 1960 that the design intent of the TX-53 was to ensure that fuzing-system restrictions on the bomb release altitude were less severe than limitations imposed by safe escape or other criteria. It was felt that, except for a minor altitude restriction for some retarded contact bursts, this design intent appeared to have been met. The fuzing system thus appeared to provide the necessary flexibility for the intended use of the bomb, and formal concurrence in the design was requested.[32] Field Command subsequently replied, noting that the Strategic Air Command stated that the release capabilities of the TX-53 Bomb were acceptable.[33]

Laydown tests demonstrated that the terminal velocity of the TX-53 Bomb was less than anticipated, and a change to the nose design was made which reduced the overall length of the bomb and provided better clearance in the B-47 bomb bay. It now became possible to jettison the parachute and its container in the free-fall option, and this change shifted the weapon center of gravity far enough forward so that aerodynamic stability was attained without deployable fins.[34]

A study of a warhead to be carried by the TITAN missile was reported March 13, 1960. This called for use of a high-yield warhead at ranges up to 5500 nautical miles, and a lighter weight warhead for targets 8500 miles distant. The XW-38 Warhead was being developed for application to the TITAN and ATLAS missiles for the latter usage, and consideration was given to the TX-53 design for the shorter range, higher yield employment. The warhead could be severely reduced in weight over the bomb application, as the impact-mitigation system would not be needed.[35]

On May 17, 1960 the Director of Defense Research and Engineering requested the Atomic Energy Commission to participate in a feasibility study of warheads to be used with the TITAN II or SM-68B intercontinental ballistic missile system.

(b)(1), (b)(3)

The study report was published July 12, 1960, and recommended development of an XW-53 Warhead.

(b)(1), (b)(3)

The TITAN missile operational date was March 1963 and it was felt that the warhead could be provided at the same time. It was noted that if production authorization were received in the near future, flight tests could be started by November 1961, design release made in the same month, and early production achieved by December 1962.[37]

The Director of Defense Research and Engineering requested the Atomic Energy Commission, September 1, 1960, to proceed with development of the XW-53 Warhead, with the Air Force being designated cognizant agency for the Department of Defense, and normal Defense Atomic Support Agency participation.[38]

The military characteristics for the TITAN warhead were approved by the Military Liaison Committee October 18, 1960. Fuzing options included air burst with contact backup and contact burst.

(b)(1), (b)(3)

Sandia wrote to Albuquerque Operations Office March 10, 1961, discussing the development program definition for the XW-53. Sandia would be responsible for design and production specifications of the warhead, with the exception of explosive and nuclear parts. General Electric would develop the re-entry vehicle, and Glenn L. Martin Company would be in charge of missile development. Warhead design release would be in April 1962 with early production in January 1963.

per second. A disreefed 48-foot, three-parachute cluster replaced a 44-foot cluster.

The Air Force decided to provide the three 48-foot parachutes with a 22-1/2 foot reefing line and a 1-second reefing time. This resulted in an overload on the second parachute stage. To reduce this load and to move some of it to the first stage, the reefing-line length was increased to 25 feet. This design functioned satisfactorily, but the loads extrapolated to an overly high figure for the maximum drop conditions of the bomb. Sandia dropped a unit and found that two of the three parachutes failed completely by breaking the suspension lines.[41]

Sandia notified the Division of Military Application May 12, 1961, that the bomb production date would have to be delayed due to lack of a satisfactory retardation system. The Division of Military Application requested that another program assessment be made after drops scheduled for early June 1961.[42]

A meeting was held June 27, 1961 to discuss the results of the BLU-2/B drop-tower and laydown programs. There had been wide variation in test results, although drop conditions had been kept relatively constant. It appeared that the angle of impact significantly affected impact accelerations, and it was decided that the rest of the drop-tower program would be delayed until enough laydown tests had been completed to determine whether the drop-tower velocities were realistic.[43] Subsequently, Sandia reported, August 8, 1961, that 10 drop tests had been made of a half-scale beer-barrel nose. Results showed that the nose was capable of reducing the longitudinal impact acceleration to less than 100 g's.[44]

The Air Force Special Weapons Center notified Albuquerque Operations Office November 30, 1961, that the parachute was compatible with the TX-53 Bomb as carried in B-47 and B-52 aircraft.

(b)(1), (b)(3)

Field Command notified Sandia January 23, 1962, that Report SC4553(WD), Proposed Ordnance Characteristics for the XW-53 Warhead, had been reviewed in coordination with representatives of the interested Services. The review established that the design met all the requirements of the approved military characteristics, with certain exceptions.

The diameter of 40.5 inches over the mounting flange exceeded the 37.5 inches allowed by the military characteristics, but this was acceptable, as was the warhead length of 103.5 inches rather than the desired 102 inches. It was felt that considerable increase in safety could be realized if the environmental sensing device were upgraded to minimize the possibility of its being inadvertently operated or bypassed in a fire environment, and it was requested that efforts be directed toward such improvement.

(b)(1), (b)(3)

Otherwise, the design was acceptable to the Department of Defense.[46]

Sandia wrote to Albuquerque Operations Office January 31, 1962, noting that a proposed acceleration of the XW-53 Warhead design, with release in October 1962 rather than February 1963, would require issuance of information considered premature even for the later date. Deliveries of development hardware had been delayed and there were progressive slippages in the flight-test program. However, every attempt would be made to provide certified production material by the date requested and, if not, operative components would be made available.[47]

Field Command notified Sandia February 13, 1962, that Report SC4621(WD), Interim Development Report for the TX-53 Basic Assembly and TX-53 Bomb, had been reviewed in coordination with representatives of the interested Services. There were a few deviations from the military characteristics. There was no warhead entity as such, but the basic assembly included the warhead elements, as well as all fuzing and firing components except the impact-fuzing or deformation switch, and this deviation was acceptable.

(b)(1), (b)(3)

Effective length of the TX-53 was 148.75 inches to the rear automatic deployment cover, slightly more than desired, but this length was compatible with designated carriers and was acceptable. The weight was 8850 pounds, slightly more than specified, and this also was acceptable.

(b)(1), (b)(3)

This latter capability would be provided at a later date.

(b)(1), (b)(3)

Sandia subsequently notified Field Command May 10, 1962, that the Mk 53 had three power sources; aircraft monitor and control system, fast-rise thermal batteries, and main-fuzing-system thermal batteries. The electrical system of the bomb had been designed so that the firing-system circuits were physically separated from any circuits likely to receive power in the event of fire. It was thus felt that the bomb provided sufficient fire safety, but thermal fuses would be included in the fuzing-system selector control as an added safeguard.[49]

The Mk 53 Bomb and the Mk 53 Basic Assembly were design-released August 10, 1962. It was noted that the B-47 bomb-bay spoiler doors had to be retracted for both high- and low-altitude releases to prevent adverse bomb pitchdown at release.[50]

(b)(1), (b)(3)

switch had to be manually turned to the ARMED position (either retard or free fall) before takeoff, or a weapon dud would result. The fuzing-system control selector provided choice of air or contact burst. Laydown delayed burst was automatically selected when the bomb was released below its specified altitude, with the aircraft monitor and control selector placed at AIR or GROUND.

When the bomb was released from the carrying aircraft, pullout rods were extracted, and this action activated pulse generators which initiated fast-rise thermal batteries and a set of sequential timers. The batteries supplied power to baroswitch and timers, and activated another set of thermal batteries.

(b)(1), (b)(3)

About one second after weapon release, sequential-timer contacts closed and completed circuits between battery pack and detonators in the automatic parachute deployment system. At the same time, the timer provided a signal that severed the retardation-parachute suspension lines, and the following deployment sequence occurred: The automatic deployment cover was separated from the rear case section by the explosion of a length of mild detonating fuse, the cover deployed a 4-foot-diameter pilot chute, the pilot chute deployed a 16.5-foot ribbon retardation chute permanently reefed to 12 feet, and the retardation chute deployed the laydown parachute system, which consisted of three 48-foot ribbon chutes, each reefed to 22.5 feet for 2 seconds after line stretch.

The laydown parachute system was designed to reduce the rate of fall of the bomb to less than 55 feet per second, and to position the bomb upright at the instant of impact. The energy of impact was absorbed by aluminum honeycomb in the bomb nose. Since strong surface winds might cause the bomb to fall over on its side, similar shock-absorbing material was placed around the bomb components.

As the rotary switch remained in the laydown option in low-altitude releases, main battery power was supplied to the laydown bus after bomb release. Retardation created by the laydown parachute caused an interval timer to operate toward its armed position, applying main battery power to the motor and contacts of the sequential timer.

(b)(1), (b)(3)

At detonation time a third switch closed, activating explosive switches and triggering the spark gap to cause bomb detonation.

(b)(1), (b)(3)

Less than one second after bomb release, the rotary switch turned to the high-level option position. Shortly afterward, the sequential timer completed a circuit between battery pack and detonators in the automatic parachute deployment system. If free-fall option had been selected, closure of contacts in the sequential timer applied power from fast-rise thermal batteries to parachute deployment system and severed the chute attachments, allowing the retardation chute to extract and discard the laydown parachute in its stowage can. If the retarded option had been selected, the sequence was similar to that for free fall, except that the parachute deployment proceeded normally.

Air-burst option could be selected by the aircraft monitor and control system.

(b)(3)

(b)(1), (b)(3) Less than 1 second after weapon release, the option switch operated to the high-altitude option. Closure of a timer 1 second after release had no effect on Pod operation.

(b)(3)

If contact option had been selected on the Warhead Control Selector Switch before release, the fire baro was bypassed and the Pod contact crush switch was brought into the circuit. The firing pulse transformer circuit was completed by the impact crush switch which closed on impact with the target.[60]

(b)(1), (b)(3)

Report SC-WD-64-574, Final Development Report for the Mk 53 Mod 0 Warhead, was issued by Sandia in December 1965. This noted that the warhead system used a rotary chopper/converter system to change low-voltage direct current at about 28 volts to about 2100 volts direct current. An environment similar to the launch acceleration of the TITAN II missile had to be experienced to complete the converter arming circuit. This acceleration operated the environmental sensing device.

When two independent arming signals were applied to both chopper and converter, the applied voltage was chopped, transformed, rectified and used to charge the X-unit capacitor bank and arm the trigger circuit.

(b)(3)

Detonation of an armed warhead could be accomplished by either a low-voltage (17 volts) or high-voltage (250 volts) method. The output of the trigger circuit was applied to one probe of the dual-probe spark gap. This signal caused ionization of the spark gap, and energy stored in the X-unit capacitor bank was transferred to the detonators, causing detonation of the warhead. Energy from the capacitor bank also triggered an explosive timer on the neutron generators. This timer burned down and detonated the explosive driver which depoled a ceramic crystal. The crystal then supplied a high-voltage pulse to a deuterium-tritium tube which provided neutrons for initiation.[62]

Glossary of Mk 53 Terms

Air Force Special Weapons Center -- That element of the Air Force Systems Command having to do with compatibility testing of nuclear devices with aircraft. Located at Kirtland Air Force Base, Albuquerque, New Mexico.

Albuquerque Operations Office -- The local office of the Atomic Energy Commission (AEC) concerned with the operations of Sandia Corporation.

Armed Forces Special Weapons Project -- An interdepartmental agency formed to handle military functions related to atomic weapons.

Assistant Secretary of Defense -- Created by Department of Defense directive, June 30, 1953, as part of DOD reorganization. Handles research and development of activities of the DOD.

Ballistics -- The science governing motion of projectiles or bombs dropped from aircraft.

Baro -- A pressure-sensitive device used in weapons to actuate circuits. The term is a contraction of "barometric switch," a switch actuated by air pressure, sometimes referred to as "baroswitch."

Boosting -- The technique of increasing the yield of a nuclear device by introducing deuterium-tritium gas into the implosion process to increase fission activity.

(b)(1), (b)(3)

Defense Atomic Support Agency -- An interdepartmental agency formed to handle military functions related to atomic weapons. Originally called the Armed Forces Special Weapons Project.

<u>Department of Defense</u> -- The Armed Forces, i.e., the Army, Navy and Air Force.

<u>Design Review and Acceptance Group</u> -- A Military committee established to review the design of a specific weapon. It absorbed some of the functions of the Special Weapons Development Board.

<u>Detonators</u> -- Explosive devices which, when initiated ~~(see bridge wires)~~ by the X-unit, ignite the lens charges of the high-explosive sphere (which see).

<u>Deuterium</u> -- The hydrogen isotope of mass number 2.

<u>Development Program Definition</u> -- A report that describes the weapon to be designed and the steps that will be taken in its development.

<u>Director of Defense Research and Engineering</u> -- Change of name for the Assistant Secretary of Defense.

<u>Division of Military Application</u> -- An AEC office that functions as liaison between the Military and weapons designers and producers.

(b)(1), (b)(3)

<u>Field Command</u> -- The local office of the Armed Forces Special Weapons Project *(Defense Atomic Support Agency), located on Sandia Base, Albuquerque, New Mexico.*

<u>Firing System</u> -- The electrical system of the weapon that produces and applies a high-voltage current to the detonators.

<u>Free-Fall Bomb</u> -- A bomb that falls under the forces of gravity and the impetus given at time of release.

(b)(1), (b)(3)

<u>One-Point-Safe Weapon</u> -- A weapon that will not produce a nuclear yield when detonated at one point on the surface of the high explosive.

<u>Operation Hardtack</u> -- See Hardtack.

<u>Reservoir</u> -- As used in this history, a container for deuterium-tritium boosting gas.

<u>Retarded Bomb</u> -- A bomb provided with some means for slowing the rate of descent, generally a parachute.

<u>Ribbon Parachute</u> -- A parachute having a set of ribbons in place of a solid canopy. This type of parachute provides less severe deceleration on deployment.

(b)(1), (b)(3)

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(b)(3)

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